Claims

1. A method for controlling the moisture profile and/or moisture gradient of a paper web for producing a high-quality and uncoated paper, in particular of at least SC quality, on an on-line or off-line multi-nip calender (1) which is situated before a slitter-winder of the web and which comprises at least two roll stacks (21, 22; 31, 32), each of them having at least three rolls, and which calender is provided with a pre-moisturizer (7) which is situated before the calender and in which the web is moisturized in the width i.e. cross direction transverse to its running direction substantially across the entire width of the web from an initial moisture content M0 before pre-moisturizing W1 to a desired pre-moisture content M1 before the calender (1), and with an intermediate or additional moisturizer (3) which is arranged before the last roll stack and after a first calendering nip of the first roll stack in order to moisturize the web in the cross direction substantially across its entire width at least before the last roll stack (31, 32) to a desired intermediate moisture content M2, in which last roll stack the web is dried to a desired final moisture value M3, **characterized** in that for continuously controlling and optimizing the thickness-direction, i.e. z-direction moisture profile and/or moisture gradient of the web in the calender (1) by means of the pre-moisturizing W1 of the web, the pre-moisturizer (7) situated before the calender (1) is controlled by means of the final moisture value M3 of the web in the calender (1) of the web.

2. A method as claimed in claim 1, **characterized** in that the pre-moisturizer (7) of the web is controlled by means of the final moisture value M3 of the web after the calender (1).

3. A method as claimed in claim 1 and/or 2, **characterized** in that the intermediate or additional moisturizer (3) of the web is controlled by means of the final moisture value M3 of the web after the calender (1).

4. A method as claimed in any one of claims 1 to 3, **characterized** in that the pre-moisturizer (7) and/or the intermediate or additional moisturizer (3) is/are controlled manually and/or automatically.

5. A method as claimed in claim 4, **characterized** in that the final moisture value M3 is passed to serve as a control parameter of the pre-moisturizer (7) and calculated from the values: the pre-moisture value M1 of the web, which value corresponds to the moisture value of the web after the pre-moisturizing W1 of the web before the first roll stack (21, 22) of the calender (1); evaporation E1, E2,...En of moisture that has occurred in each roll stack (21, 22; 31, 32); and the intermediate moisturizing W2 of the web carried out by means of each intermediate moisturizer (3) of the web.

6. A method as claimed in claim 4, **characterized** in that evaporations E1, E2,...En and the additional or intermediate moisturizing W2 of the web are passed to serve as a subtotal, and that said subtotal E and the pre-moisture value M1 of the web are passed as separate variables through a coupling means (11) to serve as a control parameter of the pre-moisturizer (7).

7. A method as claimed in any one of claims 1 to 6, **characterized** in that the final moisture content of the web is calculated with the formula M3 = M1 + 100 %·(E1 + W2 + E2)/square metre of web, where

M1 [%] = pre-moisture content of the web before the calender,

E1 [g/m$^2$] = evaporation of moisture per square metre of web in the first roll stack (21, 22),

E2 [g/m$^2$] = evaporation of moisture per square metre of web in the second (31, 32),

W2 [g/m$^2$] = intermediate or additional moisturizing of the web per square metre of web.

8. A method as claimed in any one of claims 1 to 7, **characterized** in that the final moisture value M3 which has been either measured or calculated in the coupling means (11) is passed by means of the coupling means (11) to serve as a control parameter of the pre-moisturizer (7).

9. A system for controlling the moisture profile and/or moisture gradient of a paper web for producing a high-quality and uncoated paper, in particular of at least SC-quality, on an on-line or off-line multi-nip calender (1) which is situated before a slitter-winder of the web and which comprises at least two roll stacks (21, 22; 31, 32), each of them having at least three rolls, and which calender is provided with a pre-moisturizer (7) which is situated before the calender and in which the web is moisturized in the width i.e. cross direction transverse to the running direction of the web substantially across its entire width from an initial moisture content M0 before pre-moisturizing W1 to a desired pre-moisture content M1 before the calender (1), and with an intermediate or additional moisturizer (3) which is arranged before the last roll stack and after a first calendering nip of the first roll stack in order to moisturize the web in the cross direction substantially across its entire width at least before the last roll stack (31, 32) to a desired intermediate moisture content M2, in which last roll stack the web is dried to a desired final moisture value M3, **characterized** in that for continuously controlling and optimizing the thickness-direction, i.e. z-direction moisture profile and/or moisture gradient of the web in the calender (1), the pre-moisturizing W1 of the web is controlled by a control parameter of the pre-moisturizer (7) situated before the calender (1), which control parameter corresponds to the final moisture value M3 of the web.

10. A system as claimed in claim 9, **characterized** in that the final moisture value M3 of the web after the calender (1) or an equivalent value controls the pre-moisturizing W1 of the web by means of the pre-moisturizer (7).

11. A system as claimed in claim 9 and/or 10, **characterized** in that the final moisture value M3 of the web in the web portion after the calender (1) controls the intermediate moisturizing W2 of the web by means of the intermediate or additional moisturizer (3).

12. A system as claimed in any one of claims 9 to 11, **characterized** in that the pre-moisturizer (7) and/or the intermediate or additional moisturizer (3) is/are controllable manually and/or automatically.

13. A system as claimed in any one of claims 9 to 12, **characterized** in that the final moisture value M3 of the web is a control parameter of the pre-moisturizer (7) and measured by means of a moisture meter (10) situated after the calender (1) or calculated from the values: the pre-moisture value M1 of the web, which value corresponds to the moisture value of the web after the pre-moisturizing W1 of the web before the first roll stack (21, 22) of the calender (1); evaporation E1, E2,...En of moisture that has occurred in each roll stack (21, 22; 31, 32); and the intermediate moisturizing W2 of the web carried out by means of each intermediate moisturizer (3) of the web.

14. A system as claimed in claim 13, **characterized** in that the evaporations E1, E2,...En from the web and the intermediate or additional moisturizings of the web have been summed to form a subtotal that corresponds to the total change of the moisture content of the web in the calender (1), and that said subtotal and the pre-moisture value M1 of the web (1) have been passed as separate variables to a coupling means (11) to provide a control parameter of the pre-moisturizer (7).

15. A system as claimed in claim 14, **characterized** in that the evaporations E1, E2,...En from the web (1) have been summed to form a subtotal that corresponds to the total evaporation $\Sigma$En of moisture in the calender (1), and that said subtotal, the intermediate or additional moisturizing W2 of the web and the pre-moisture

content M1 of the web have been passed as separate variables to the coupling means (11) to provide a control parameter of the pre-moisturizer (7).

16. A system as claimed in claim 9 and/or 10, **characterized** in that the final moisture value for providing a control parameter of the pre-moisturizer (7) has been passed directly or through a coupling means (11) to serve as a control parameter of the pre-moisturizer.

17. A system as claimed in any one of claims 9 to 16, **characterized** in that the final moisture content of the web has been calculated with the formula

$M_3 = M1 + 100\ \% \cdot (E1 + W2 + E2)$/square metre of web,

in which formula

M1 [%] = pre-moisture content of the web before the calender,

E1 [g/m$^2$] = evaporation of moisture per square metre of web in the first roll stack (21, 22),

E2 [g/m$^2$] = evaporation of moisture per square metre of web in the second roll stack (31, 32),

W2 [g/m$^2$] = intermediate or additional moisturizing of the web per square metre of web.

18. A system as claimed in claim 17, **characterized** in that the intermediate moisture content of the web has been calculated with the formula $M2 = 100\ \% \cdot [M1 + (E1 + W2)$/square metre of web,

in which formula

M1 [%] = pre-moisture content of the web before the calender,

E1 [g/m$^2$] = evaporation of moisture per square metre of web in the first roll stack (21, 22),

E2 [g/m$^2$] = evaporation of moisture per square metre of web in the second roll stack (31, 32),

W2 [g/m$^2$] = intermediate or additional moisturizing of the web per square metre of web.

19. A system as claimed in any one of claims 9 to 18, **characterized** in that the final moisture value of a multi-layer web in particular can be calculated with the formula M3 = M1 + W + E, where

M1 = pre-moisture content of a multi-layer web (typically about 5 %) before calendering,

W1 + W2 = total moisturizing during calendering per square metre of web, W1 being pre-moisturizing of the web per square metre of web and W2 being intermediate or additional moisturizing of the web per square metre of web, and

the total evaporation from the web per square metre of web during calendering = ΣEn, where En is the total roll stack evaporation per square metre of web in a single roll stack,

so that advantageously M3 = M1 + x · (W1 + W2) - ΣEn = moisture content of the multi-layer web (typically about 3 %) after calendering, in which formula x = 0.5 - 1.0, when the multi-layer web is overdry, i.e. M1 < M3; x = 0.3 - 0.7, when M1 = M3; and x = 0 - 0.5, when M1 > M3.

20. A method as claimed in any one of claims 9 to 19, **characterized** in that the final moisture value M3 either measured or calculated in the coupling means (11) has been passed coupled to serve as a control parameter of the pre-moisturizer (7), so that it is possible to select

A) based on the final moisture value of the web, either manual control of the pre-moisturizer of the calender or control of the pre-moisturizer of the calender

- by a calculated final moisture value M3
- by a measured final moisture value M3, or

B) control of the flow of an additive from an additives tank into a headbox (6) of a paper machine, the flow of a filler from a fillers tank into the headbox of the paper machine, or control of the flow of fibre raw material from a fibre raw material chest into the headbox of the paper machine to produce a multi-layer web.

21. A calender for controlling the moisture profile and/or moisture gradient of a web for producing a high-quality and uncoated paper, in particular of at least SC quality, which calender is an on-line or off-line multi-nip calender (1) which is situated before a slitter-winder of the web and which comprises at least two roll stacks (21, 22; 31, 32), each of them having at least three rolls, and which calender has been provided with a pre-moisturizer (7) which is situated before the calender and in which the web is moisturized in the width i.e. cross direction transverse to the running direction of the web substantially across its entire width from an initial moisture content M0 before pre-moisturizing W1 to a desired pre-moisture content M1 before the calender (1), and with an intermediate or additional moisturizer (3) which has been arranged before the last roll stack (31, 32) and after a first calendering nip of the first roll stack (21, 22) in order to moisturize the web in the cross direction substantially across its entire width at least before the last roll stack (31, 32) to a desired intermediate moisture content M2, in which last roll stack (31, 32) the web is dried to a desired final moisture value M3, **characterized** in that for continuously controlling and optimizing the thickness-direction, i.e. z-direction moisture profile and/or moisture gradient of the web in the calender (1), the pre-moisturizing W1 of the web is controlled by a control parameter of the pre-moisturizer (7) situated before the calender (1), which control parameter corresponds to the final moisture value M3 of the web.

22. A calender as claimed in claim 21, **characterized** in that the calender comprises two separate roll stacks, and that the intermediate or additional moisturizing of the web after the pre-moisturizing W1 has been arranged before the last roll stack (31, 32) of the calender (1) and after the first calendering nip of the first roll stack (21, 22).

23. A calender as claimed in claim 21, **characterized** in that the centre line c1 passing through the axes of the rolls of the roll stack of the calender or the centre line of a parallelepiped-shaped border line surrounding the calender is, with

respect to the horizontal machine plane, vertical, horizontal or inclined with respect to the vertical plane.

24. A calender as claimed in any one of claims 21 to 23, **characterized** in that roll combinations of the roll stacks are determined with the formula $n_2 + m_3$, in which $n_2$ = the number of rolls in the roll stack (21, 22) and $m_3$ = the number of rolls in the roll stack (31, 32), the numbers $n_2$ and $m_3$ being both an odd integer whose value is at least 3 and it can be even 9 or higher.

25. A calender as claimed in any one of claims 21 to 24, **characterized** in that the last calendering nip of the first roll stack (21, 22) is placed on the same plane in the horizontal direction as the first calendering nip of the second roll stack (31, 32).

26. A calender as claimed in any one of claims 21 to 25, **characterized** in that the number of the rolls (21, 22, 31, 32) is odd in a calender in which a hard press roll (22; 32) and an elastic backing roll (21; 31) are placed alternately one after the other.

27. A web, advantageously a fibrous web, such as a paper web, most advantageously a paper web of at least SC quality, manufactured by the method as claimed in any one of claims 1 to 9, by the system as claimed in any one of claims 1 to 19 or by the calender as claimed in any one of claims 20 to 26 from a pulp that contains mechanical pulp and/or chemical pulp, which has a basis weight of 30 to 80 g/m$^2$, **characterized** in that in the range of roughness of the web between 0.8 and 2.0 µm, the average Hunter gloss of the web, as an average value of the upper-lower surfaces, is at least 45 %, advantageously > 50 % even > 53 %.

28. A web as claimed in claim 27, **characterized** in that in the range of roughness of the web, i.e. 0.8 – 2.0 µm, Hunter gloss, as an average value of the upper-lower surfaces, is at least 55 %, advantageously 58 % even > 60 %.